Five-minute Science Lesson: Types of Scientific Reasoning

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Reasoning is a cognitive process involving the use of knowledge to develop rational inferences, conclusions and explanations about one's experiences and about reality. Several types of reasoning have been described, including *inductive reasoning, deductive reasoning and abductive reasoning*.

Inductive reasoning

Induction, in logic, is the process of attempting to make generalizable statements from particular observations. Inductive reasoning is therefor the process of making generalized conclusions from discrete or specific situations. Because such observations are based on available data, conclusions achieved through inductive reasoning can be correct insofar as the available evidence. However, inductive conclusions may not be correct for other unavailable data. This is the main reason why anecdotal examples – though they may be useful for illustrating knowledge that has be acquired through more reliable methods, and may also be useful for introducing new questions about the limits of our present knowledge – are regarded as an insufficient basis for scientific conclusions. Inductive reasoning involves a minor premise that is certain while the major premise and conclusion are to some degree uncertain. Accepting inductive conclusions as fact is a logical fallacy.

Deductive reasoning

Deduction refers to the logical process in which inferences or conclusions about a particular observation or situation follow necessarily from more general conclusions that are accepted as correct premises. If the general statements are correct then the inferences or conclusions about a particular are accepted as inevitable. In contrast to inductive reasoning, in which there is some degree of variation surrounding a conclusion, deductive conclusions are invariate, given the accuracy of the general premises. Deductive reasoning involves both major and minor premises that, if accepted as certain, lead to a conclusion that is equally certain.

Abductive reasoning

Abductive reasoning is a process of making observations about a particular instance or set of instances, and then developing the most plausible, most economical or most likely generalizable conclusion with the acknowledgement of some inherent uncertainty. Selection of

a particular conclusion is often based on probability and on the principle of parsimony – selecting the simplest explanation that accounts for the broadest range of observations. Because abduction is subject to some inherent uncertainty, the process of abductive reasoning can emphasize objective and reproducible quantification of the degree of uncertainty that surrounds a conclusion. Much of our knowledge acquired from research during the last century is accepted through the process of abductive or probabilistic reasoning. Because abductive conclusions, like inductive conclusions, are based on available data, it is possible that different subsets of data may support different possible conclusions. The larger process of abductive reasoning will treat smaller conclusions, based on subsets of data, as data points that are themselves subject to ongoing adbuctive reasoning, with the larger goal of achieving an economical or parsimonious and generalizable conclusions that can be applied to all subgroups. Whereas deductive conclusions are accepted as certainty, and whereas inductive conclusions are accepted as situational, abductive conclusions are accepted as probable based on available information.

Other types of reasoning

The word *reason* can sometimes be synonymous with *logic*, and other types of reasoning have been described, besides the inductive, deductive and abductive variants already describes. Some of those other types of reasoning can include *metaphorical reasoning*, in which a different, more familiar or more intuitive, exemplary context is used to introduce a new abstract concept. *Allegorical reasoning* is somewhat similar, involving the use of story-telling in which conclusions and hidden meaning are conveyed in a context that is detached from oneself and the immediate context. Cognitive psychologists have described what they refer to as *emotional reasoning*, a form of cognitive distortion or thinking error in which the generation or experience of emotion is interpreted or accepted as proof that a conclusion is correct.

Another problematic form of biased reasoning has been described as *motivated reasoning* in which logic and information are fitted conveniently to a preselected conclusion that is seen as most desirable. Motivated reasoning is sometimes the result of emotional attachment to a particular conclusion. This is in contrast to a critical thinking approach in which all conclusions are regarded with skepticism and subject to unbiased analysis, carefully avoiding the egocentric problem of inability to consider perspectives other than one's own. Finally, *transductive* reasoning has been described in child development literature as a form of fallacious reasoning observed in children during the preoperational stage of cognitive development, when children have limited real knowledge about how things work, and limited actual understanding about cause-and-effect. In transductive reasoning, unassociated coincidental phenomena are misattributed as related. Because transductive conclusions are based on a failure of understanding of cause-and-effect, these conclusions can sometimes become exemplars for childlike magical thinking, or more simply wishful thinking, in which a person accepts something as fact simply because they think so.